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SCIENCE

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NEO-DARWINISM AND NEO-LAMARCKISM.

By LESTER F. WARD.

Annual address of the President of the Biological Society of Washington delivered Jan. 24, 1891. A historical and critical review of modern scientific thought relative to heredity, and especially to the problem of the transmission of acquired characters. The following are the several heads involved in the discussion Status of the Problem, Lamarckism, Darwinism, Acquired Characters, Theories of Heredity, Views of Mr. Galton, Teachings of Professor Weismann, A Critique of Weismann, Neo-Darwinism, Neo-Lamarckism, the American "School," Application to the Human Race. In so far as views are expressed they are in the main in line with the general current of American thought, and opposed to the extreme doctrine of the non-transmissibility of acquired characters.

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What is the Problem?

In seeking a means of protection from lightning-discharges, we have in view two objects,—the one the prevention of damage to buildings, and the other the prevention of injury to life. In order to destroy a building in whole or in part, it is necessary that work should be done; that is, as physicists express it, energy is required. Just before the lightning-discharge takes place, the energy capable of doing the damage which we seek to prevent exists in the column of air extending from the cloud to the earth in some form that makes it capable of appearing as what we call electricity. We will therefore call it electrical energy. What this electrical energy is, it is not necessary for us to consider in this place; but that it exists there can be no doubt, as it manifests itself in the destruction of buildings. The problem that we have to deal with, therefore, is the conversion of this energy into some other form, and the accomplishment of this in such a way as shall result in the least injury to property and life.

Why Have the Old Rods Failed?

When lightning-rods were first proposed, the science of energetics was entirely undeveloped; that is to say, in the middle of the last century scientific men had not come to recognize the fact that the different forms of energy—heat, electricity, mechanical power, etc.—were convertible one into the other, and that each could produce just so much of each of the other forms, and no more. The doctrine of the conservation and correlation of energy was first clearly worked out in the early part of this century. There were, however, some facts known in regard to electricity a hundred and forty years ago; and among these were the attracting power of points for an electric spark, and the conducting power of metals. Lightning-rods were therefore introduced with the idea that the electricity existing in the lightning-discharge could be conveyed around the building which it was proposed to protect, and that the building would thus be saved.

The question as to dissipation of the energy involved was entirely ignored, naturally; and from that time to this, in spite of the best endeavors of those interested, lightning-rods constructed in accordance with Franklin's principle have not furnished satisfactory protection. The reason for this is apparent when it is considered that the electrical energy existing in the atmosphere before the discharge, or, more exactly, in the column of dielectric from the cloud to the earth, above referred to, reaches its maximum value on the surface of the conductors that chance to be within the column of dielectric; so that the greatest display of energy will be on the surface of the very lightning-rods that were meant to protect, and damage results, as so often proves to be the case.

It will be understood, of course, that this display of energy on the surface of the old lightning-rods is aided by their being more or less insulated from the earth, but in any event the very existence of such a mass of metal as an old lightning-rod can only tend to produce a disastrous dissipation of electrical energy upon its surface,—"to draw the lightning," as it is so commonly put.

Is there a Better Means of Protection?

Having cleared our minds, therefore, of any idea of conducting electricity, and keeping clearly in view the fact that in providing protection against lightning we must furnish some means by which the electrical energy may be harmlessly dissipated, the question arises, "Can an improved form be given to the rod, so that it shall aid in this dissipation?"

As the electrical energy involved manifests itself on the surface of conductors, the improved rod should be metallic; but, instead of making a large rod suppose that we make it comparatively small in size, so that the total amount of metal running from the top of the house to some point a little below the foundations shall not exceed one pound. Suppose, again, that we introduce numerous insulating joints in this rod. We shall then have a rod that experience shows will be readily destroyed—will be readily dissipated—when a discharge takes place; and it will be evident, that, so far as the electrical energy is consumed in doing this, there will be the less to do other damage.

The only point that remains to be proved as to the utility of such a rod is to show that the dissipation of such a conductor does not tend to injure other bodies in its immediate vicinity. On this point I can only say that I have found no case where such a conductor (for instance, a bell wire) has been dissipated, even if resting against a plastered wall, where there has been any material damage done to surrounding objects.

Of course, it is readily understood that such an explosion cannot take place in a confined space without the rupture of the walls (the wire cannot be boarded over); but in every case that I have found recorded this dissipation takes place just as gunpowder burns when spread on a board. The objects against which the conductor rests may be stained, but they are not shattered.

I would therefore make clear this distinction between the action of electrical energy when dissipated on the surface of a large conductor and when dissipated on the surface of a comparatively small or easily dissipated conductor. When dissipated on the surface of a large conductor,—a conductor so strong as to resist the explosive effect,—damage results to objects around. When dissipated on the surface of a small conductor, the conductor goes, but the other objects around are saved.

A Typical Case of the Action of a Small Conductor.

Franklin, in a letter to Collinson read before the London Royal Society, Dec. 18, 1755, describing the partial destruction by lightning of a church-tower at Newbury, Mass., wrote, "Near the bell was fixed an iron hammer to strike the hours; and from the tail of the hammer a wire went down through a small gimlet-hole in the floor that the bell stood upon, and through a second floor in like manner; then horizontally under and near the plastered ceiling of that second floor, till it came near a plastered wall; then down by the side of that wall to a clock, which stood about twenty feet below the bell. The wire was not bigger than a common knitting needle. The spire was split all to pieces by the lightning, and the parts flung in all directions over the square in which the church stood, so that nothing remained above the bell. The lightning passed between the hammer and the clock in the above-mentioned wire, without hurting either of the floors, or having any effect upon them (except making the gimlet-holes, through which the wire passed, a little bigger), and without hurting the plastered wall, or any part of the building, so far as the aforesaid wire and the pendulum-wire of the clock extended; which latter wire was about the thickness of a goose-quill. From the end of the pendulum, down quite to the ground, the building was exceedingly rent and damaged. . . . No part of the aforementioned long, small wire, between the clock and the hammer, could be found, except about two inches that hung to the tail of the hammer, and about as much that was fastened to the clock; the rest being exploded, and its particles dissipated in smoke and air, as gunpowder is by common fire, and had only left a black smutty track on the plastering, three or four inches broad, darkest in the middle, and fainter towards the edges, all along the ceiling, under which it passed, and down the wall."

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SCIENCE

NEW YORK, MAY 5, 1893.

THE SO-CALLED "SAP" OF TREES AND ITS MOVEMENTS.[1]

BY CHARLES R. BARNES, PROFESSOR OF BOTANY, UNIVERSITY OF WISCONSIN, MADISON, WIS.

THE subject which I have chosen to present to you this evening is not chosen so much on account of the information which I am able to impart as for the purpose of correcting a great deal of misinformation which is widely prevalent. Many false ideas as to the nature and movements of what is popularly known as the sap of trees are extant, and in a large number of cases these ideas are founded upon mistaken notions of the physiology of plants. Our own knowledge about many of these matters is yet exceedingly imperfect, and it is for that reason that many of my statements will of necessity be negative. The subject also is one which must have considerable interest for those who are so intimately engaged in cultivating fruit and shade trees as are the members of this society; and I take it that no fact in regard to the life and mode of working of the plants with which we are so constantly dealing will be entirely without interest.

What is Meant by "Sap?"

It will be necessary for us at the outset to gain some accurate idea, if possible, of what is meant by the word "sap." If we think for a moment of its various uses, we shall see that it is a word which designates not a fluid of definite composition, but one under which is included a great variety of watery solutions. The sugar-maker begins even before the snows have left the ground to collect from wounds in the trunk of the maple-trees a sweetish liquid which he calls "sap." After a considerable time the proportion of sugar which this liquid contains diminishes very greatly, and he then abandons his work because, as he says, the "sap" has become too poor. The man who has postponed pruning his grape-vines or trees to too late in the season finds that from the cut surfaces a watery substance is trickling which he calls "sap." But the sugar-maker will be unable to obtain either sugar or syrup from this fluid, which is, however, called by the same name as that from which he manufactures his sweets. When a boy, who is making a whistle, hammers the bark of the twig in the spring, he finds it easy to separate the bark, because, as he says, the surface of the wood is then slippery with "sap." The sap of the boy is widely different from the sap of the pruner and the sap of the sugar-maker.

Again, what we do not call sap may furnish us with some illustrations of the diversity of meanings of this term. We do not ordinarily speak of the "sap" of the apple, or of the "sap" of the grape, or of the "sap" of the orange, but call the fluids which these fruits contain "juice." And yet they are not more different in their composition from those fluids which we do call sap, than the three examples already mentioned are different from each other. We might therefore, in all reason, apply this word sap to the juices of fruits.

We popularly distinguish the older hard internal wood of the tree under the name of "heart wood," from the younger, softer, and lighter-colored external wood, which we call the "sap wood." To the fluids which saturate the sap wood we are constantly in the habit of applying the word "sap," but I have never heard it applied to the exactly similar fluids which saturate the heart wood. As far as the composition of these fluids is concerned, there is no reason why that in the heart wood should not equally well be designated as sap.

[1] An address delivered before the State Horticultural Society of Wisconsin, February, 1893; stenographically reported, and revised by the author.

What then are we to understand by the word "sap?" Evidently not a substance of any definite composition; but the word signifies only in the most general way the various watery fluids which are found in the plant. There is no reason indeed why these solutions should not be called *water*, for in many cases they are almost as pure as the water which we drink. In the chemist's sense, the water which we draw from our wells is a watery solution of various substances, and yet we do not designate it commonly by any other term than simply "water." In a similar manner, it is quite proper for us, and perhaps it would conduce to clearness of ideas, to designate the watery solutions in plants simply by the term "water," understanding it in its popular and not in its strictly chemical sense.

Movements of Water in Trees.

Let us turn now to the consideration of the movements which the water in trees exhibits. I shall confine my remarks to trees simply for the reason that they present the greatest variety of water movement, and at the same time furnish the greatest difficulties in the explanation of these movements. If, therefore, we understand the movement of water in trees, we shall be able readily to transfer these ideas to the movement of water in the smaller plants, although the statements applicable to the trees are not always applicable to the smaller plants, because of their greater simplicity; however, the greater includes the less.

The Evaporation Stream.

In the first place, there is need of a very considerable amount of water to supply the constant evaporation which is going on from the leaves of trees. Immense areas of delicate tissue are exposed to the dry air, and oftentimes to the hot sun, in the form of foliage, and from this foliage there is going off at such times large quantities of water in the form of vapor. The water needed to supply this evaporation must come from the soil, because it is not possible for the leaves to take in any water, not even when they are wet by the rains or by the dews. The water enters, not at the base of the trunk where the large roots are found, but only at the extremities of the finest rootlets. At these points the rootlets are clothed with a "nap" or "pile" of fine hairs. These root-hairs must not be confounded with the fine branches of the root, for it is only the finest branches which are covered with the close-set hairs. Consequently, it is only the youngest and most delicate parts of the root which allow the entrance of the water. But the water escapes from the leaves, and from the point of entrance to the point of exit is a far cry for the coursing droplets. How does it pass through this long space?

It is just here that our knowledge is most defective. We know a number of things that are true in regard to it, and we know a number of things which are not true in regard to it.

We know that it moves in the sap wood of the tree, and neither in the bark or in the heart wood. Many of you must have made observations which are sufficient to establish this point. You have, for instance, observed that the bark of trees might be peeled off for a considerable distance, and that the leaves would still retain their green color and their freshness. In many cases, indeed, the mere removal of the bark from the tree is not sufficient to bring about its death until several months, and in some trees not until several years, after the injury. Death, however, is inevitable sooner or later; but the fact that the leaves remain fresh for so long a time is evidence that the supply of water is not interfered with. Death ensues from a totally different cause, namely, from the starvation of the roots in a way which will be explained later.

Again, you must have observed that it is quite possible to have the entire heart wood of the tree removed, as is often done by decay

and yet to have the leaves remain fresh and green for an indefinite time. In fact, the rotting-out of the heart wood scarcely interferes with the vitality of the tree, except as it renders it mechanically weaker, and consequently more liable to be overthrown by storms. If any further proof were needed, it is perfectly possible to show experimentally that the sap wood alone is engaged in the transfer of the water required for evaporation by cutting into it. A saw-cut which passes through the sap wood, but leaves the heart wood intact, brings about within a very short time the withering of the leaves. In some trees, indeed, a cut which severs only the outer youngest layers of the sap wood will produce the same effect, since in such trees *only* the youngest layers of the wood carry the water. By experiments on twigs it can be demonstrated that withering will occur even if the bark is almost completely uninjured.

We know the water to supply evaporation moves chiefly in the cavities of the elements of the wood. The wood of the tree is composed of a large number of *fibres*, that is, elongated cells pointed at both ends, and of *ducts*, that is, tubes of great length formed by the breaking together of rows of cells placed end to end. You can get an idea of the manner in which these ducts are formed by imagining a series of round pasteboard boxes piled one on top of another, after which the top and bottom of each is removed, so that, instead of a series of separate chambers, we have now a long tube. The fibres may be likened to a series of lead pencils, sharpened at each end, and placed in contact with each other, the points of the lower ones overlapping the next ones above and fitting in between them. In my illustration the cavity of the fibre would be represented by the lead, and it would be more accurate if we could conceive of the cavity as not extending entirely through the pencil, but stopping short of the point. Minute pits extend from the cavity of one of these fibres to the other, and the walls also of the long ducts are also marked by larger thin spots. It is in the cavities of these ducts and fibres that the water chiefly travels.

We do not know what part is taken in this ascent of the water by those peculiar elements of the wood which you know by the name of silver grain or the pith rays. You will remember these as the shining plates of tissue which extend from the centre of the wood toward the circumference. They are particularly prominent in the oak and show most when it is split "with the grain." It is probable that these cells have a great deal to do with the movement of water, but their exact *rôle* is not fully agreed upon.

We are in almost total ignorance at the present time as to the force by which the water is elevated through so many feet. There are trees in the gullies of Victoria, Australia, whose height exceeds 470 feet, and we must invoke some force which is able to raise water from the level of the soil to the level of the highest leaf. A year ago we thought we had a hypothesis which would account for this movement, but later researches have brought to light some facts which are at present totally irreconcilable with what was a most charming, and, at that time, a most satisfactory explanation, and we shall be obliged to abandon it unless the wine of the new knowledge can be held by the old bottles of theory.

At the time when our knowledge of capillarity was greatly extended by the celebrated researches of Jamin, it was thought that we had knowledge of a force adequate to account for the raising of water to these great heights. The fibres and ducts which I have described to you seemed to answer very perfectly the requirements of capillary attraction, and it was thought that this force, by reason of which water rises through narrow spaces, was the one sought. But the rise of water in capillary spaces is proportioned to the size of the opening; the smaller the opening, the higher will it rise. With the decrease of the calibre of the tubes, however, the friction increases enormously, and only small quantities will be able to be moved on account of the diminished size of the tubes. It was quickly seen that, in order to account for a rise of even a hundred feet, the tubes of the wood must be vastly smaller than they really are.

When it was found that the air in a plant is under a less pressure than that outside the plant, it was thought that the force had been discovered, and that atmospheric pressure furnished the explanation. Negative pressure, however, on the interior never reaches zero, and consequently cannot account for a rise of more than 33 feet.

Again, what was called root-pressure was invoked to explain the phenomena. It is found that water is absorbed at certain times so rapidly by the roots that it exists in the plant under considerable pressure, and it has been claimed that root-pressure, combined with the other forces already known, was adequate to account for the rise of water. But this, too, has failed us.

It is perhaps the greatest weakness of the last theory (that of Godlewski), which we have just had to abandon temporarily at least, that it depended for its explanation upon the indefinite and illusive "vitality" of certain portions of the plant. Godlewski's brilliant hypothesis, which ascribes to the activity of the living cells of the medullary rays the function of receiving from lower levels the water and passing it on to higher tissues through rhythmic variations in their osmotic power, due possibly to respiratory changes, may yet hold the clue which we are seeking. But when Strasburger jacketed a young tree for a distance of 35 feet, and kept it surrounded by hot water until all of the living cells in the tree trunk were unquestionably killed, and when under these circumstances the water-supply to the leaves was not interfered with, so that they remained green and fresh, we were obliged to conclude that the lifting of the water is not dependent upon the life of the tissues directly, but that it is evidently carried on by a physical process yet to be explained.

Before passing from this topic of the movement of water which supplies evaporation, I must allude to a very common and wide-spread idea,—at least I judge it to be widespread, because it is so frequently propounded by my students,—that "the sap goes down in winter and up in the spring." Just where the sap is supposed to go in winter is not exactly clear; since, if the roots are absorbing water in the fall when the evaporation is diminished, they are likely to have quite as much water as they can hold already. The conception, apparently, is that all of the water lodged in the trunk and spreading branches goes downward into these roots. It needs, however, only the most casual examination of trees in winter to discover that at this time they are almost saturated with water. The twigs of the hickory tree, for example, will be frozen on a cold day in winter, so that they are as brittle almost as glass, and one can snap off a twig half an inch in diameter as though it were an icicle. The same twig, when not frozen, on a mild day will be so tough that there will be no possibility of breaking it.

Again, if one cuts off a branch from a tree in winter and brings it into a warm room, he will quickly discover that water is oozing from the cut end, showing that the twigs are almost saturated with it. As a matter of fact, the water in trees increases from mid-summer or early fall to the beginning of growth in early spring. There is thus no necessity for any "going up" of the sap in spring until the leaves are expanded and the water with which the tree is already saturated begins to be evaporated from the foliage.

Bleeding.

A second movement of water in trees is that which occurs in the so-called "bleeding." The bleeding of trees occurs at different times of the year, either before growth has begun at all, or just as it is beginning. In the two cases the cause is quite different. We find a good example of both sorts of bleeding in the gathering of the sap by the sugar-maker. This gathering begins at the time when the ground is still frozen and the roots are almost or quite unable to absorb any water, but at a time when the air is warmed through the middle of the day by the increased heat of the sun. At first the expulsion of water from wounds made in the trunk is due to the expansion by heat of the air inside the smaller branches and twigs of the tree. This sets up at once a pressure upon the water, and this pressure is transmitted to all parts of the tree. The water with which the tree is filled is thereby forced out as soon as an opening is made for its escape. Later in the season, however, the roots begin their work of absorption, and there is then set up the so-called *root-pressure*, by reason of which the water is forced out at the same openings.

The latter sort of bleeding is necessarily delayed until growth is about to begin, and is checked as soon as the foliage is sufficiently expanded to begin evaporation.

A bleeding similar to the last takes place at the hood-like tips of grass leaves, where the skin is nearly always ruptured. The little drops of water which accumulate here are commonly mistaken for dew, but are merely droplets exuded from the interior of the leaf, because the falling temperature of the air toward evening has diminished the evaporation from the leaves, while the roots in the warm soil are still absorbing water, and consequently producing an internal pressure. The movement of water in these cases of bleeding, it will be seen, is necessarily toward the point of exit, which may be above or below the point at which the pressure arises.

Secretion of Nectar.

A third sort of movement of water is that which takes place in the nectaries of flowers and leaves. The flowers of our common linden, for example, secrete a considerable quantity of sweet fluid, which is sometimes miscalled "honey," but is properly known as nectar. Honey, by the way, is nectar after it has been digested by the bees. At certain points in the flower there are groups of cells whose special business it is to withdraw water from the parts below, and filter it through their outer walls, after having added to it the materials which make it sweet. The movement of water in this case is extremely limited.

The Transfer of Food.

The last movement of water of which I shall speak is of those solutions which contain the food of the plant. These materials are not those absorbed from the soil, or gathered directly from the air, but they are the substances which have been manufactured by the leaves out of the materials obtained from the soil and from the air. Since these foods are put together in the leaves, necessarily the movement of water containing them in solution must be in a different direction from that which supplies the evaporation. The materials thus manufactured in the leaves must be carried either to those parts which are growing or to those places in which they are to be stored for future use. It is manifest at the first glance, therefore, that the direction of the movement must be in general *inwards* from the leaves, and, since the roots require for their nutrition a considerable amount of these substances, there must be a very decided *downward* movement to supply them.

Now it is plain that these solutions of food must keep out of the way of those portions of the water which are chiefly to supply the evaporation from the leaves. We have seen that the latter travel in the sap wood. The food currents, however, travel almost exclusively in the inner parts of the bark. You will therefore understand why stripping off the bark, or even cutting it, ensures the death of the tree eventually, even though the leaves remain long unwithered, since the roots depend upon the food formed by the leaves, they perish when severed from their base of supplies.

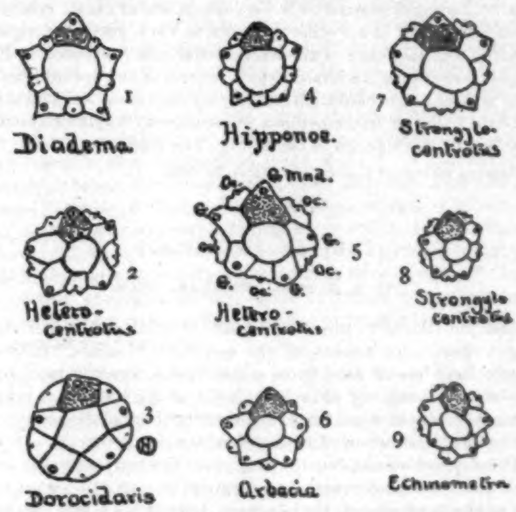
The movement of the evaporation stream is relatively rapid. The movement of this food current is relatively slow. We do know something of the mode of movement of these food currents. They are apparently brought about through the process known as diffusion, or osmosis, and are therefore necessarily slow. The cause of the movement is practically the same as that for the movement of oil in the lamp-wick, although it is by no means by the same method. The oil in the lamp-wick travels upward because at the top it is being destroyed *as oil* by reason of the heat of the flame. So the direction and existence of the current of water carrying food is because the various substances dissolved in the water are being altered at the place of growth or storage into new materials. The commonest of these food substances is sugar, and at the growing point of the stem, for example, the sugar is being constantly destroyed as sugar and is being converted into cellulose or protoplasm or some other material. So long as that alteration is going on, just so long will the sugar particles move toward that point.

But I must not impose further upon your patience. I have tried to sketch very briefly, and only in outline, the different movements which the water in the plant is undergoing. I have said nothing of the extreme variety of materials which may be found in this water in different plants, or even the variety found in the same plant at different times, but have endeavored merely to show you that there is going on constantly in the living tree a series of molecular and mass movements, of which too few people have any conception. To our imperfect knowledge let me hope that some of you may contribute facts which shall enable us some day to explain the many things which are now obscure.

NOTE ON THE SEA-URCHIN SKELETONS.

BY HENRY LESLIE OSBORN, PH.D., ST. PAUL, MINN.

IN looking through the drawings of students in the freshman class of the aboral ring in *Strongylocentrotus droebachiensis* from Portland, Maine, I came upon one which I at first supposed to be erroneous, but which, on comparison with the specimen, proved the specimen to be exceptional. The usual arrangement of the genital and ocular plates in this species is shown in Fig. 7 of our cut. The five genital plates and two of the oculars border upon the anal ring, the three remaining oculars being shut out by



the contiguity of the enlarged genitals. The arrangement found by exception is figured at 8. It consists in the exclusion of four oculars from the aboral ring, so that only one gets a share in forming the border. I seized the occasion to look into the cases of about fifty specimens which happened to be on hand in the laboratory, and found that the case of Fig. 8 occurred twice in that series and that all others were like Fig. 7, which is normal, and which I have observed in many more than fifty different specimens at different times. It is interesting to note that in Fig. 122 of Agassiz's "Seaside Studies," page 103, a drawing of a specimen of this species is given, in which three ocular plates border the aboral ring, and in which the plates are thus quite symmetrical. This must be of very exceptional occurrence, for I have never met it in the many specimens I have seen. I should be very glad to know if it has been at all generally observed.

In connection with the case of Strongylocentrotus, it is interesting to examine the aboral ring of other regular echinoids. In *Diadema* (Fig. 1) the ring is perfectly regular, with five genitals and five oculars of equal size; in *Arbacia* (Fig. 6) it is equally regular, but with five large genitals, which form a ring about the aboral area, and exclude from it wholly the five small genitals. In *Dorocidaris* (Fig. 3) the ring is nearly regular, four oculars barely reaching the ring, the fifth being shut out. In *Hipponoe* (Fig. 4) the case is nearly as in *Diadema*, one ocular, however, not reaching the ring. In *Echinometra* (Fig. 9), a very elongate urchin, but not elongate in the plane of the madreporic plate, the five oculars do not any of them reach the ring and the

ring is very asymmetrical, being elongate in the major axis of the elliptical specimen. In *Heterocentrotus*, too (Figs. 2 and 5), the body is elliptical and the ring is asymmetrical, being longer in the direction of the major axis of the specimen. In this genus (one figured from the Bermudas [5] and one from the Philippine Islands [2]) there is only one ocular which borders the ring, a second barely reaching it in 5 or not really doing so in 2, this is not like the case presented in Fig. 8, the exceptional Strongylocentrotus, for there the lateral and not the median ocular is the one which surely borders the ring. A number of undetermined Echinoids at hand from the Pacific Ocean closely resemble Strongylocentrotus, and in them the aboral ring is like Fig. 7.

These comparisons have interesting morphological suggestions. *Dorocidaris* is a central form, as well as an early one palæozoölogically, in it the oculars are neither wholly on nor wholly excluded from the ring; from it *Diadema* is a departure toward and *Arbacia* from the ring, and all three of these are tolerably radial in symmetry. *Hipponoe* is a slight departure from the regular symmetry of the aboral ring, all the rest are not radial. The elongations of *Echinometra* and *Heterocentrotus* are in the same plane in each case, but the plane is not in the plane of the madreporic plate, as it is in the departures from radial and toward bilateral symmetry in clypeastrids and spatangids. The aboral pole of Strongylocentrotus is very much out of radial symmetry, though the shell in all other respects is very perfectly regularly radial. The meaning of the exceptional case presented in Fig. 8 might perhaps be understood as a reversion toward an ancestral form in which the oculars were all excluded from the aboral ring. I cannot think of any adequate physiological explanation of the relations of these bones in either Fig. 7 or Fig. 8.

Hamline Biological Laboratory, March 24, 1893.

THE CANALS OF MARS.

BY S. E. PEAL, SIBSAGAR, ASAM.

THE question as to the distribution of land and water on the planet Mars, and nature of the so-called "canals," is one on which there has of late been considerable speculation; and in the hope of throwing some little light on the subject, it may not be amiss to draw attention to a recent geological discovery relating to the distribution of land and water on our earth.

At no very distant period it was generally supposed that terrestrial continents and oceans had frequently — or at least occasionally — changed places, that oceanic islands, as a rule, were the summits of submerged or emerging ranges, the last relics, or forerunners, of extensive land masses. All this is now changed, and one of the most recent and important discoveries of modern geology is the fact that the great continental masses and deep ocean floors are permanent features of the earth's crust.

On p. 150, "Island Life," Mr. A. R. Wallace tells us that "there is the strongest cumulative evidence, almost amounting to demonstration, that for all known geological periods our continents and oceans have occupied the same general position they do now." And at p. 330, "during the whole period of geologic time, as indicated by the fossiliferous rocks, our continents and oceans have, speaking broadly, been permanent features of our earth's surface." Referring to ocean floors, Mr. J. Murray again says, "The results of many lines of investigation seem to show that in the abysmal regions we have the most permanent areas of the earth's surface." While M. Faye points out that "under the oceans the globe cools down more rapidly and to a greater depth than beneath the surface of the continents. At a depth of 4,000 metres the ocean will still have a temperature not remote from 0° C., while at a similar depth beneath the earth's crust the temperature would be not far from 150° C."

Last, Professor James Geikie, in his address to Section E, geography, of the British Association, says, "We must admit that the solid crust of the globe has always been subject to distortion, and this being so, we cannot doubt that the general trends of the world's coast-lines must have been modified from time to time by movements of the lithosphere. . . . It seems to be the general opinion that the configuration of the lithosphere is due to the sinking in and crumpling up of the crust on the cooling and contracting nucleus." "According to Professor Winchell the trends (of the great world ridges and troughs) may have been the result of primitive tidal action. He was of opinion that the transmeridianal progress of the tidal swell, in early incrustive times, on our planet, would give the forming crust structural characteristics and aptitudes trending north and south. The earliest wrinkles to come into existence, therefore, would be meridianal, or submeridianal, and such is certainly the prevalent direction of the most conspicuous earth features." "So far as geological research has gone, there is reason to believe that the elevated and depressed areas are of primeval antiquity — that they antedate the very oldest of the sedimentary formations. We may thus speak of the great world-ridges as regions of dominant elevation and of the profound oceanic troughs, as areas of more or less persistent depression."

The great areas of elevation and of persistent subsidence are very distinctly marked out on our earth by a meridianal-lobed arrangement, caused, as Professor G. H. Darwin thinks, by *tidal* rupture during early stages of crust formation. This great recent discovery is, therefore, one of the greatest importance to all seeking for the solution of the problem of the distribution of land and water on Mars.

Tested by our moon, and viewing the marea as "seas" now in some way solidified, the foregoing conclusions are borne out in the most remarkable manner on the hemisphere which is presented towards us.

From Walter to Cassini we have distinct evidence (of different kinds) of the existence along the prime meridian of a vast shoal or submerged continent lying north and south, bordered on the east by the series of marea, Nubium, O. Procellarum, and Imbrium, and on the west by Nectaris, Tranquilitatis, and Serenitatis, each series of three marea having a meridianal trend. Near the limb again, east and west, we see the well-known two series of vast walled plains, lying north and south, the great Sirsalis cleft, also north and south, 400 miles long, being a vast anticlinal surface-fracture.

That the persistent subsidence of ocean floors (an axiom in terrestrial geology) is also clearly seen in our moon, is well illustrated in the remarkable arrangement of the clefts in relation to the marea, viewed as areas of subsidence. In regard to this question, Mr. A. C. Ranyard in *Knowledge*, September, p. 173, says: "The evidence brought forward by Mr. Peal, with regard to the general subsidence of the great lunar marea seems to me conclusive." So that the two features of slow subsidence of ocean floors and meridianal arrangement of the land and sea areas due to primeval tidal rupture during crust formation, are seen on both globes of the earth-moon system.

But the arrangement of the land and sea areas on Mars is on a totally different plan, there is an entire absence of equatorial oceans, and of meridianally placed continents divided, as in our case and the moon, by wide troughs of subsidence. We see on that globe two vast polar oceans divided by a more or less continuous land girdle.

We may reasonably assume that on Mars the crust-formation began on the poles, and that, as time went on and further condensation took place, subsidence and formation of polar sea-basins would ensue, their floors, being the coldest and densest portion of the crust, persistently sinking in, would naturally cause the emergence of the equatorial land-girdle. The comparatively unbroken continuity of this latter would again be due to the absence of a large satellite causing tidal rupture: there would be no breaking-up of the emerging land girdle round the equator, during crust-formation, as in the earth-moon system.

Professor G. H. Darwin thinks that the effect of solar tides on Mars must be "inconsiderable," they might yet, however, be sufficient to cause and maintain a slight overspill from one polar ocean-basin into the other, as the northern or southern hemispheres were presented towards the sun.

During the equinoxes, also, for some months, twice a year, solar attraction would probably draw the water from each polar

basin during the daytime through the lowest levels on to the equatorial land-girdle, the ebb taking place at night.

Persistently in operation from the very earliest periods, these two causes might well establish and maintain well-marked tidal channels, the so-called "canals," in fact, and in this way solve these enigmatical features. Their being open to the seas at each extremity is a powerful argument in favor of the above view.

With such an effectual and continuous circulation of the water from the polar basins, over the tropical areas, we may perhaps see the solution for the remarkable mildness of the climate on Mars and smallness of the polar caps. The thermal effects of our Gulf Stream would be produced not only at one spot, or even one pole, but all round; each polar basin would have currents of warmer water poured in daily.

The occasional duplicity of the canals may perhaps be due to a series of large islands, as seen so frequently in terrestrial rivers flowing through alluvial tracts. Viewed from a great elevation, our Brahmaputra would undoubtedly appear double for hundreds of miles, especially in the dry season when the large sand "churs" or islands fill the bed of the river, though even in the rains there are many, more or less permanent, of large size, such as our "Majulé," or middle ground, 180 miles in length by 10 or 20 wide, giving the appearance of a series of vast loops. The rule indeed is that this large river is seldom seen confined to one channel.

The remarkable feature of the whole case seems to be that so far there has been little or no reference to terrestrial experience when discussing the problem of the distribution of land and water on Mars. The great recent geological discoveries bearing on the subject appear to have been overlooked, but if the law of the permanent subsidence of ocean floors, now an axiom among geologists, and so clearly seen on our moon, applies to Mars, we can see more or less clearly that the coldest and densest portions of the Martian crust will be the floors of the two polar ocean basins, the slow, steady subsidence of which causes the emergence of the equatorial land-girdle; the comparative completeness of this, again, being due to the absence of a large satellite, to cause tidal rupture during formation.

Last, we seem to see an intelligible solution for the so-called "canals," as modified tide-channels, and even for their occasionally appearing double; the exceptionally effectual circulation of the water on the planet being the solution for the mildness of the climate.

NOTES AND NEWS.

THE expedition, equipped by the de Laincel fund for linguistic and paleographic research among the Maya remains of Mexico, under the charge of Dr. Hilborne T. Cresson of the Bureau of Ethnology, Washington, D. C., reached Mexico in January and proceeded to the Partedo de la Frontera near the Guatemalian border and from thence to the little-known region around the lake of Petin. While in this part of the country the guide died of malarial fever, and Dr. Cresson, accompanied by his Maya servant, continued the explorations until the season was too far advanced for further research. The expedition has been very successful in the collection of material which will aid in deciphering the Maya hieroglyphs and demonstrates a rich field for future study both paleographic and linguistic. It has been found that exact drawings made by the pencil the size of the original glyph or half-size, will be most serviceable for giving details which repeated trials of the camera failed to satisfactorily produce, as many of the minor components, which recent study has shown to be very important in the interpretation of the glyphs, are so delicate in execution and so worn by time that the impression is calculated to deceive the student. Moreover, the forests which surround the ruined Maya structures are very dense and a proper light for photography is impossible to be obtained, and even if enough space was cleared for light the cast shadows of the tablets themselves lead to erroneous lines, when the negative is printed. A comparison of photographs of paper squeezes, made by previous expeditions, shows that much of this work has been hurriedly done and the minor components more or less distorted by being carelessly removed, so making them almost useless for exact study.

— An important meeting of the Victoria Institute took place on April 17, at Adelphi Terrace, London, the president, Sir Gabriel Stokes, Bart., in the chair; after the election of several new members and associates, Major C. R. Conder, R.E., D.C L., read a paper on "The Comparison of Asiatic Languages," in which he dealt with the ultimate relationship of the great divisions of Asiatic speech, forming the separate families called Aryan, Semitic, and Mongolic, and the affinities of the oldest monumental languages in the Akkadian and the Egyptian. After describing the accepted principles of internal comparison of languages in each group, Major Conder urged that the roots, to which philologists have referred all words in each family, run — in a large number of cases — through all these families, probably indicating a common source of language. He proceeded to draw results as to the primitive condition, and original home, of the Asiatics, and pointed out that Egyptian was grammatically to be classed with Semitic languages, and Akkadian with Mongolic speech. A comparative list of some 4,000 ancient words, from the languages in question, accompanied the paper, which was listened to throughout by a large and appreciative audience. The discussion was commenced by Professor Legge of Oxford University, who, referring to the work of his life as a student of Chinese for upwards of half a century, urged the value of such work as that done by Major Conder. In all his comparisons, he was possibly not prepared to agree, but that did not prevent him from recognizing the great value of what he had done, and the evidence afforded by such researches as to the primitive unity of the human race. Prof. Legge's remarks were followed by those of Mr. T. G. Pincher, the Akkadian scholar, Professor Koelle, Dr. Kenneth Macdonald, Professor Postgate, Principal R. Collins, and others. Captain F. Petrie, the honorary secretary, during the evening read an important communication from one of the members exploring in Egypt, in which some newly-discovered sculptures were described, these threw quite a new light on the mode of transporting immense masses of stone by water, which was in use among the Egyptians in the days of the Pharaohs.

— Professor S. S. Laurie's work on "John Amos Comenius" has been republished in this country by C. W. Bardeen of Syracuse, with a preface and a bibliographical appendix. Professor Laurie begins with a brief study of the Renascence and the Reformation in their relation to education, and then proceeds to an account of the checkered and roving life of the great Moravian bishop and educator. Then, taking up the leading works of Comenius, he endeavors to show what were the real contributions made by him to educational theory and practice. His principal merit, as Professor Laurie justly says, was in the method of teaching which he advocated, a method greatly in advance of that practised in his own time and similar in many respects to that followed by the best teachers of to day. What the method was may be learned in detail from this book, where it is set forth at considerable length. He held that we ought to copy the methods of nature, and his works are filled with fanciful analogies between her operations and the labors and processes of the teacher. His own text-books, however, especially those for the study of languages, are often as unfit for their purpose as they could well be, and his whole method is of too formal a character, and is vitiated, as Professor Laurie remarks, by the belief that a man can be manufactured. Moreover, his idea of knowledge was too utilitarian, and he had no appreciation of philosophy or of art and the esthetic side of literature and life. Nevertheless, his method was a great improvement on that of his contemporaries, and his advocacy of milder discipline was equally commendable. He also advocated the Baconian study of nature; and in these days, when natural science and utilitarian studies have become prominent, and so much stress is laid upon right methods of teaching, it is not strange that his life and work have become objects of interest. Few persons, however, will care to study his own writings, and hence this book, which gives so full an account of them, will serve a useful purpose.

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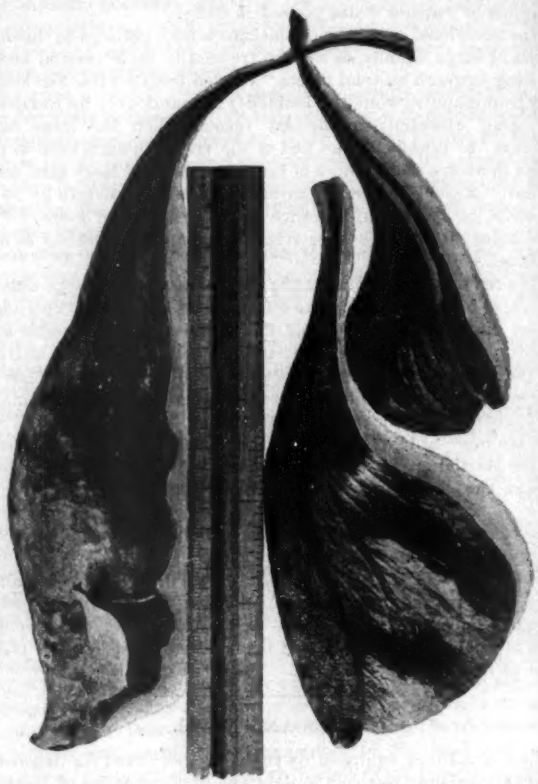
Attention is called to the "Wants" column. It is invaluable to those who use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

THE PRODUCT OF A CHANGED ENVIRONMENT.

BY GEORGE H. HUDSON, STATE NORMAL AND TRAINING SCHOOL, PLATTSBURGH, N. Y.

TOWARD the latter part of September or early in October 1891, a number of pitcher plants (*Sarracenia purpurea*, L) were sent to me from Wolf Pond, Franklin Co., N. Y., together with other bog plants, for our school Wardian case. This case is 120 cm. long, 51 cm. wide, 45 cm. deep, and stands before an east window where it does not get very much light, save on sunny mornings. We keep in this case many kinds of mosses, ferns, some fungi, and several small animals such as salamanders, toads, wood-frogs, young alligators, and different insect larvæ. This case also furnishes abundant material for microscopic study, such as rhizopods, infusorians, rotifers, etc. The pitcher plants were carefully set out in the east side of the case, and for several months the pitchers were kept filled with water, and were occasionally fed with flies and bits of meat. Later in the season the plants were neglected; the pitchers were not filled with water, nor was any kind of animal food given them. In the late spring there were two plants living. These plants had begun to increase the width of the leaf-like margin of their pitchers while the hoods and tubes themselves were suffering a marked change. These changes were intensified during the summer, and the result is shown by the reproduction of a photograph taken Nov. 5, 1892. This photograph shows an old and somewhat decayed phyllodium from one of the two plants, and, in contrast with it, one of the new phyllodia from each. These new phyllodia are bright green, without a trace of the usual coloring, serving to attract insects, save on the very edge of the aborted and flattened hood, where a faint border about 2 mm. deep may be noticed. Some of these hoods have not opened; the hairs which line others are in an immature and useless condition. The leaf-like margins of these curiously modified petioles, instead of being from one-fourth to one-third the width of the tube as in normal specimens, have become from three to four times the width of the now weak and flattened tube. The scale photographed with these phyllodia will show the extent of this modification. The scale shows inches on the left and centimetres on the right. Of the next older phyllodia the larger hoods have decayed, while the tube and its wing-like expansion are still in a healthy condition. This pitcher plant grows wild in Plattsburgh, and I have seen it in many places in the Adirondack region, but I have never noticed such wide margins in a state of nature. Was the change in our Wardian case made because of the absence of animal food, which made it necessary for the plant to look in other directions for its support? Was it made because of the absence of the influence of water in its tubes while it was forming these new phyllodia? Was the plant obliged to sacrifice its pitchers in order to extend its chlorophyl-bearing surface on account of the loss of light? The changes made, it will be noticed, were just those changes which would best bring it into harmony with its changed environment. Was this change made in response to the demands of the new environment, or were the changes but the reversion to an ancient type consequent simply on the diminished vitality of the plant? This curious change suggests many experiments which might easily be made to determine the extent to which certain lower organisms could vary in response to external stimuli, and thus be able to adapt themselves to unusual conditions in a changed or changing environment.

Early in the winter one of the little toads used to get into a large prostrate phyllodium, apparently to take a bath. We have noticed him a number of times sitting just within the hood with



his body partly in the water. The red, spotted salamanders crawl over the alligator and share the sunny portions of the case with him. Believing these bright-colored beings not fit for food, he has offered the little things no violence. One of the small garden toads did not fare so well but became a victim of a pair of jaws that broke his bones in their embrace.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Variation in Native Ferns.

THE wide variation in the forms of British ferns is well known to all who read the works of English florists, but there is less of this in America. Scolopendrium vulgare will have different auricles at the base, and sometimes is forked at the apex, but it varies little beyond this. I have found Woodsia ilvensis also with a forked apex, but this rare.

Aspidium acrostichoides is much more variable in many ways. Almost any woodland will present differing forms, as regards

scales, form of frond, and division of pinnæ. Several times I have found fronds clearly pinnatifid in the lower part. This might be called an extreme form of the variety *Incisum*, and is most likely to occur late in the season, and in rich woods undergoing the process of clearing. The pinnæ are also sometimes once or twice forked at the apex, and there are other changes from the normal form.

Camptosorus rhizophyllus is less variable, but the basal auricles will sometimes be prolonged much like the apex, and will root like that. Specimens have thus been found giving origin to three young plants. I have one frond which is pinnate, but with a normal frond from the same root.

The Osmundas vary much. O. regalis has often a few sporangia on the otherwise sterile pinnæ, and O. Claytoniana has sometimes the same feature. I have a curious series of O. cinnamomea, where the so-called variety Frondosa is fertile at the base and apex, at the base alone, at the apex alone, or only in the centre. There are other oddities in this fern.

The Botrychiums vary much. The variations of B. virginianum are well known, and the variety *Gracile* is quite persistent in some places. B. matricariæfolium varies from age and location, but I have found many distinct and beautiful varieties of B. ternatum growing luxuriantly together. In one abundant plantation of B. simplex there are many strange forms, not altogether due to age. This is in sphagnum, and not far off I have found it growing in water.

The variation of Cystopteris fragilis is a never-failing perplexity to some. It seems so different, and yet so familiar. Often it has been mistaken for Woodsia obtusa.

Some ferns which I collected in Colorado were interesting to Professor Underwood from their local variation in a broad sense, being near the limits of their district. I collected Aspidium septentrionale on Cheyenne Mountain, but it was immature, yet those of the preceding year were smaller and quite unlike those I had from Europe.

On Skaneateles Lake, N.Y., I found small patches of Pellæa gracile growing on wet rocks; in one place, almost in the bed of a small waterfall. In other places there I found it on dry ledges, the roots and tufted fronds forming a dense mat. The station made quite a difference in the appearance.

W. M. BEAUCHAMP.

Baldwinsville, N.Y., April 14.

Singing of Birds.

IN answer to E. B. Titchener's inquiry regarding the relation of song to emotion in birds, the following is offered by one who has made careful observations in the language of over fifty well-known species.

That there is an expression of feeling in the notes of all of our birds no true lover of our feathered friends will attempt to deny. We are all most willing to admit the existence of a bond between them and us, and this relation, or assumption perhaps, we would not care to have dispelled. Nevertheless, although I am so anxious to invest these creatures, "favorites of creation," as Figuier so fondly calls them, with higher attributes of feeling and expression, it remains a fact, that their notes do not change in quality as a result of change in emotion. At least, this is so in so far as our ears are able to distinguish. Let us consider some cases.

A pair of robins will make a great outcry if their nest is molested, the excited notes of the male corresponding exactly to his cries when engaged in his vernal battles, or, later, when giving excited warning to its defenceless young when a marauding cat is at hand. If the eggs are taken, the pair quickly subsides, and the male will probably be singing the same evening; surely the next morning. Within a very few days a new nest is begun in the same neighborhood, the song continuing daily.

I have carefully noted the song of the warbling vireo, which is one of the few birds which sing while sitting upon its eggs. In one instance, after the set of four eggs was removed, the bird remaining near by, and uttering its querulous notes, I waited to observe. The male quickly returned to the empty nest, which it had recently left, and at once gushed forth in song. It may be that the song expressed much sorrow, or at least a complaint, but to me it was the same inspiring, ecstatic warble that I was accustomed to hear. I have robbed the nest of the scarlet tanager, rose-breasted grosbeak, wood thrush, hermit, and indigo bird, all beautiful singers, and then waited and listened, allowing ample time for the male to learn of the spoliation. In each instance the male quickly tuned up, and, to my idea, sang as sweetly as ever.

The expression of sentiment, or whatever we wish to call it, in the harsh *caw* of the common crow, or the single *cruk* of the raven, may mean as much, and probably does, as the tinkling melody issuing from the elfin winter wren. Then, too, the ever mournful, lonesome song of the wood pewee, or the solemn-sounding *hoo-hoo* of the great-horned owl, or the weird monotony of the whip-poor-will, undoubtedly answer the purpose equally with the sprightly notes of our little friend, the melodious, jingling song-sparrow. However, these notes and songs, although they may mean much to the birds, are, to our obtuse ears, ever the same.

MORRIS GIBBS, M.D.

Kalamazoo, Mich.

On a Supposed Climatic Variation in the Wing-Color of some Orthoptera.

I HAVE read with much interest the communication of Mr. Lawrence Bruner (p. 133) on the supposition that climatic differences may account for the different coloration — yellow, orange, red, blue — of the wings in some North American locusts, and, as the author requests other opinions, I will relate my experience in the Transvaal, where I made a considerable collection of orthoptera in the neighborhood of Pretoria.

Pretoria stands on the high table-land of the Transvaal; an almost treeless region, consisting of vast grassy plains well known by the name of "veld," with occasional hills or ranges of low mountains. In the dry winter season these plains are merely covered with a brown withered herbage; after the summer rains they are clothed with a more or less luxuriant crop of grasses and other plants. Consequently the conditions are very uniform throughout the area, but as I collected in the immediate neighborhood of the town of Pretoria, and during the summer season of 1890–91, the conditions of soil, climate, and altitude were absolutely identical.

My collection of orthoptera made at that time[1] affords evidence against the conclusions of Mr. Bruner, respecting the North American species, as the following list of some of my captures — a few conspicuous species — will show.

Species with orange-colored wings:—
- *Parga gracilis* Burm.
- *Phymateus leprosus* Fabr.

Species with yellow-colored wings:—
- *Catantops sulphureus* Walk.
- *Oedaleus citrinus* Sauss.
- *Oedaleus tenuicornis* Schaur.

Species with red-colored wings:—
- *Phymateus squarrosus* Linn.
- *Phymateus morbillosus* Linn.
- *Zonocerus elegans* Thurb.
- *Laphronota porosa* Stål.
- *Acridium rubellum* Serv.

Species with blue-colored wings:—
- *Oedaleus acutangulus* Stål.

It will be observed that the same genera show different coloration, as *Phymateus*, orange and red; *Oedaleus*, yellow and blue.

The philosophical conception of the origin of these bright colors is very difficult. Of course they are purely non-protective, as species thus ornamented are most conspicuous objects when on flight; and even on the ground or elsewhere, where their folded wings and sombre or greenish hues assimilate them to their surroundings, they are easily found and greedily devoured by most birds. I found their remains in the crops of many birds. Even

[1] A complete list is given in the Natural History Appendix to my "Naturalist in the Transvaal."

in the Accipitres, species of *Falco* and *Cerchneis* were found gorged with them; the Secretary bird (*Serpentarius secretarius*) is an orthopteral glutton; bustards, especially the "Gom Paauw" (*Otis kori*) can apparently exist on them alone, while flocks of the common "Spreo" (*Spreo bicolor*) make vast inroads in the immense swarms of the smaller species.

Their survival in the struggle for existence would seem to have been almost entirely dependent on their extraordinary fecundity. Only species with great vitality and immense power of reproduction could withstand the requirements of this mighty avian banquet. The origin of the brightly colored wings cannot, however, be placed to the credit of abundant vitality, as some genera of large and active species exhibit brightly and also sombre and modestly colored wings. W. L. DISTANT.

Purley, Surrey, England, April 3, 1893.

A Puzzle for Future Archæologists.

NEAR Enon, in Clark County, Ohio, is a well-known artificial mound, commonly called "Prairie Knob," while the level tract on which it is situated is called "Knob Prairie." A former pupil of mine informed me that when he was a boy his grandfather sunk a shaft in the centre of the mound down to the underlying black soil, without finding any thing of consequence. The old gentleman was disappointed, not to say disgusted, to find this cherished landmark, which he had so long held in high esteem as the supposed receptacle of the regulation quantity of "Indian" relics, so utterly barren. He thereupon determined, in the generosity of his heart, that future explorers should not go unrewarded. He therefore deposited in the hole a miscellaneous collection of stone implements, pottery, shells, old bones, etc., such as he imagined a properly constructed mound ought to contain. This done, he carefully refilled the shaft, and restored the mound to its former appearance.

Imagine the sensation that such a find as this is likely to make when brought to light by some enterprising mound explorer of the twentieth century! CHARLES B. PALMER.

Columbus, Ohio.

Pre-Historic Remains in America.

NOTWITHSTANDING Dr. Brinton's protest in *Science*, April 14, I think most readers will agree that the language I quoted from his "Races and Peoples" (not "American Race") is clearly open to the incidental criticism offered. That the physical conditions of the American continent have been a potent agency in forming a distinct race, as he explains his language, is readily admitted. I also believe they have moulded the *heterogeneous* elements which peopled the continent from different quarters, at different eras, into a comparatively "homogeneous race," but it is difficult to understand the process of rendering "homogeneous" those already one in race and derivation.

If Dr. Brinton has failed to observe a marked difference between the Atlantic and Pacific types, I presume it is because he has not made the comparison with this thought in view, as it is certainly very apparent. His reference to the few shells and copper articles found in Tennessee and Georgia bearing Mexican and Central American designs is unfortunate for his position. He knows, or ought to know, that these are looked upon by all archæologists as puzzling objects because of their remarkable departure from the types of the Atlantic slope. This fact is, of itself, evidence of the general impression in the minds of archæologists of the differences between the art types of the two regions.

He asks, "Is he [Thomas] not aware that both the Nahuatl and Maya languages trace their affinities exclusively to the eastern and not the western water-shed?" Not claiming to be a linguist, I must present as my reply the words of one who is.

Dr. D. G. Brinton says, in his "Races and Peoples," p. 248: "All the higher civilizations are contained in the Pacific group, the Mexican really belonging to it by *derivation* and *original location*. Between the members of the Pacific and Atlantic groups there was very little communication at any period, the high Sierras walling them apart; but among the members of each Pacific and each Atlantic group the intercourse was constant and extensive. The Nahuas, for instance, spread down the Pacific from Sonora to the Straits of Panama; the Inca power stretched along the coast for two thousand miles; but neither of these reached into the Atlantic plains." Observe that he says "all the higher civilizations," which, of course, includes the Maya as well as Mexican people. Even in his later work he reiterates this opinion. In speaking of the groups into which he classifies the stocks, he remarks: "This arrangement is not one of convenience only, I attach a certain ethnographic importance to this classification. There is a distinct resemblance between the two Atlantic groups and an equally *distinct contrast between them and the Pacific groups*, extending to temperament, culture, and physical traits" ("American Race," p. 58). Now, when it is remembered that he classes the Mexicans, and, by the above-quoted language, the Mayas also, with the Pacific group, it would seem that, at the date the book referred to was published (1891), he was advocating precisely the same view as that advanced in my letter to *Science*, as he directly contrasts the Atlantic and Pacific groups as to temperament, *culture*, and physical traits, and holds that there was very little communication between the people of the two regions. He says further of the Mayas, that "So far no relationship has been detected with any northern stock," but is inclined to look to the Mississippi Valley for their priscan home.

If Dr. Brinton still holds the view indicated in the above quotations, which are from his most recent works, I cannot understand the position he takes in his note to *Science*, as the one is in direct conflict with the other. I have not appealed to the numerous statements in his older works which differ from the views indicated in *Science*, as it appears that in the light of new data, and for reasons satisfactory to himself, he has, since 1887, entirely changed his views in reference to the origin of the people of the American continent and the course of migration so far as affected thereby. (See "Myths of the New World," 2d ed., pp. 34–35, and Address at Meeting of A. A. A. S., Salem, 1887.)

I may remark, in closing this communication, that it is very singular the numerous resemblances between the customs and arts of the West Coast Indians and Pacific Islanders, which descend even to unusual designs, have no special significance and are disposed of with the single word "illusory," while the resemblances in a few designs on shells and copper, though unusual, are sufficient to warrant us in looking to the valley of the Mississippi for the priscan home of the Mayas. Distance has, of course, to be taken into consideration in deciding as to the signification of these resemblances. What I assert is that the types of the West Coast, including Mexico and Central America, taken as a whole, have a more marked resemblance to the customs and art of what we may call the Pacific region (especially the islands) than to those of the Atlantic slope. This indicates, at least, a culture influence affecting the inhabitants of the Pacific Coast not felt on the Atlantic slope. And no theory which fails to give it more value than the mere coincident result of the "human psychical development" can abide the test of thorough examination. CYRUS THOMAS.

The Lobatcheffsky Centenary

OCTOBER 22, 1893, a century will have passed since the birth of the famous Russian geometer, Lobatcheffsky. The world is just beginning to understand that, as mental ancestors of the modern cientific theory of man and the universe, only two take rank with him, Copernicus and Darwin. Until 1826 nothing had been published to overthrow the dogma that man has absolutely exact knowledge of "the space of experience." Lobatcheffsky showed that we can never know that any rectilineal triangle in "the space of experience" has its angle-sum exactly equal to a straight angle. As one result, geometrical axioms have disappeared for ever, and are replaced by *assumptions*. Thus he re-made not only mathematics, but kenlore. The Imperial University of Kasan is justly proud of its pupil, whom it speaks of as "encompassing it with an immortal splendor." It has organized a committee to raise a Lobatcheffsky fund to establish, in honor of his birthday, a prize, open to the world, for researches pertaining to non-Euclidean geometry. As a member of this committee, I will be

glad to forward, in the name of the individual donor, any contribution toward this homage from all the enlightened world to one of the foremost names in "the pedigree of human thought."

GEORGE BRUCE HALSTED.

2407 Guadalupe Street, Austin, Texas.

Nesting of the Road-Runner.

THIS very peculiar long-tailed bird is common here throughout the year. It inhabits mainly the broad arroyos covered with chapparal thickets and scrub-oaks, as here is found its principal food, small snakes and lizards. The breeding season is from the middle of March to the last of July. The number of eggs laid varies in this locality from three to nine, though usually four to seven. The eggs are pure white, covered with a thick chalky coating which is often found partly scratched off.

The nests are built in thick chapparal bushes or scrub oaks, from two to five feet from the ground. They are composed of coarse sticks placed roughly across the supporting branches to the thickness of about two inches and a diameter of ten inches. Over this platform is placed a layer of sage leaves and twigs, forming a shallow, saucer-shaped depression. Then last, but invariably, is placed in the depression a small amount of dry horse-manure broken into small pieces. I do not know the reason of this last addition but it is nevertheless an invariable constituent of the Road-Runner's nest

The nest of the Burrowing Owl presents the same peculiarity, though with an apparent reason. The nest cavity of the Burrowing Owl is always partly filled with green horse-manure. In this case the decaying vegetable matter probably forms heat enough to carry on the incubation. But in regard to the Road-Runner's nest I do not see the necessity of the dry horse-manure.

I would be pleased to hear from any one who is acquainted with the nesting habits of the Road-Runner.

JOE GRINNELL.

Pasadena, Cal.

Ad Ignorantiam.

THE calumniators of Professor Wright have been fully met, and an animus for their attack suggested. There are some critics remaining who have used an argument not found in logic,— that "ad ignorantiam," — with freedom, and, to the users, with telling effect. A few words as to this argument may not be inopportune.

A. can neither recognize the peculiarly shaped pinnacles on the top of a glacier from day to day, nor can he remember the names of the people who are introduced to him at the receptions to which he goes. B. can do both readily, and states his ability to do so. Thereupon C. jumps up and says that it is impossible to B. to speak the truth, as it is notorious that A. can do neither, and A. is an authority on all subjects. A. finds it impossible on Monday to stake out the surface of a slippery sidewalk, and publishes the fact. On Tuesday B. comes along with knit socks over his boots and makes that sidewalk look like a dress-maker's pincushion. When this fact is published, the ubiquitous C. springs up and tells how often the frame of A. subsided in the attempts, and therefore B. never did what he claims to have done.

A whole tribe of A's fail to find Truth at the bottom of the well— all old authorities to the contrary notwithstanding—and thereupon dogmatize to the effect that she is not there or, if there, is a palimpsest edition, introduced by ex-Olympian means. When B. shins down the rope and brings up the damp and coy dame, he is met by shrieks of C., to the effect that he carried her down in his pocket, because all the A's., aided by the strongest microscopes, could not locate her within seven rows of apple trees of the place.

It may strike people as rather funny for men who have said that certain things do not exist, to prove that they do not exist by failing to find them. It is not their business to find them, or, rather, it would seriously hurt their business to find them. They cannot adduce their ignorance or inability against the knowledge and power of others who have done what they have failed to do, and what they wished to fail to do.

The writer does not think many of the questions as fully settled as they might be; but he does not propose to believe a man because he poses as an ignoramus.

EDWARD H. WILLIAMS, JR.

Bethlehem, Penn., April 14.

Color in Flowers.

IN reply to the inquiry on p. 179 will say that the preservation of colors in flower is fully explained in Professor Bailey's "Horticultural Rule Book."

F. H. PLUMB.

Springfield, Mass., April 20.

BOOK-REVIEWS.

Idle Days in Patagonia. By W. H. HUDSON. New York, D. Appleton & Co. VIII. 256 p. 8°.

THE author of "The Naturalist in La Plata," reviewed on a previous occasion in these columns, has given us in the present volume another interesting book. At first sight the title seems somewhat misleading, inasmuch as the author met with an accident a few days after his arrival in the country and was confined to the house for a considerable period. As, however, he says the book would probably never have been written if the original intentions in visiting the country had been carried out, we may consider the accident a lucky one. His "Idle Days" gave him ample time for thought, and in this as in the previous volume we have many original ideas. The most of the time was spent in the valley of the Black River, and in his chapter upon the valley we note a fact that may be of interest at the present time in view of the controversy going on in relation to palæolithic man in America. In wandering along the banks of the stream he found many arrowheads on the ancient village sites. They were of two widely different kinds, "the large and rudely fashioned, resembling the palæolithic arrowheads of Europe, and the highly-finished, or neolithic arrowheads of various forms and sizes, but in most specimens an inch and a half to two inches long. Here there were the remains of the two great periods of the Stone Age, the last of which continued down till the discovery and colonization of the country by Europeans. The weapons and other objects of the latter period were the most abundant, and occurred in the valley: the ruder and more ancient weapons were found on the hillsides, in places where the river cuts into the plateau. The site where I picked up the largest number had been buried to a depth of seven or eight feet; only where the water after heavy rains had washed great masses of sand and gravel way, the arrowheads with other weapons and implements had been exposed. These deeply buried settlements were doubtless very ancient."

He found that to the inhabitants of the valley, the river was all in all. Beyond its banks spread the gray, desolate desert; within the valley's bounds were light and life. Just as all things were mirrored in its waters, so was the stream reflected in the minds of the people. "Even the European colonists," says he, "have not been unaffected psychologically by the peculiar conditions they live in, and by the river on which they are dependent. When first I became cognizant of this feeling, which was very soon, I was disposed to laugh a little at the very large place 'the river' occupied in all men's minds, but after a few months of life on its banks it was hardly less to me than to others, and I experienced a kind of shame when I recalled my former want of reverence, as if I had made a jest of something sacred. Nor to this day can I think of the Patagonian river merely as one of the rivers I know. Other streams, by comparison, seem vulgar, with no higher purpose than to water man and beast, or to serve, like canals, as a means of transport." So powerfully did the river impress the native minds that they became incapable of imagining any place to be habitable without it.

In one chapter we have an account of the habits of several breeds of dogs. A Scotch collie was found to take kindly to the wild life in the desert and soon became the leader of the ordinary dogs. But four pure-breed grayhounds, when tired of moping about the house, would take to the desert and course on their own

account, returning, however, in a couple of days gaunt, thin and lame. Having been well fed and recovering their spirits and strength, they would again betake themselves to the desert, to return again to their master's house, worn and thin. These hounds, if left to themselves, would have soon perished, while the collie would have been successful in the struggle for existence.

Anything but a pleasing picture is drawn of the struggle the new settler has with Nature in his new home. Animals, birds, insects, and even inanimate forces are all arrayed against him, but the author considers even the severity of the struggle conducive to the well-being of the individual concerned. "The man," he says, "who finishes his course by a fall from his horse, or is swept away and drowned when fording a swollen stream, has, in most cases, spent a happier life than he who dies of apoplexy in the counting-house or dining room; or who, finding that end which seemed so infinitely beautiful to Leigh Hunt (which to me seems so unutterably hateful), drops his white face upon the open book before him. Certainly he has been less world-weary, and has never been heard to whine and snivel about the vanity of all things."

An interesting account of leaf-cutting ants is given (pp. 138-142), and the bird-music of South America is stoutly defended and favorably compared to that of Europe. He says: "The bird language of the English wood or orchard, made up in most part of melodious tones, may be compared to a band composed entirely of small wind instruments with a limited range of sound and which produces no storms of noise, eccentric flights and violent contrasts, nor anything to startle a listener — a sweet but somewhat tame performance. The South American forest has more the character of an orchestra, in which a countless number of varied instruments take part in a performance in which there are many noisy discords, while the tender, spiritual tones heard at intervals seem, by contrast, infinitely sweet and precious."

Two of the chapters deal with "Sight in Savages" and "Eyes." These have many points of interest which cannot be referred to in detail here. The one on the "Plains of Patagonia" deals with that peculiar topic of why certain scenes, inherently not pleasing or attractive, withal impress themselves upon the mind with wonderful vividness and are always recalled with pleasure. The plains are not possessed of great scenic attractions, for "Everywhere through the light, gray mould, gray as ashes and formed by the ashes of myriads of dead trees, where the wind had blown on it, or the rain had washed it away, the underlying yellow sand appeared, and the old ocean-polished pebbles, dull red, and gray, and green, and yellow." From an elevation "On every side it stretched away in great undulations: but the undulations were wild and irregular; the hills were rounded and cone-shaped, they were solitary and in groups and ranges; some sloped gently, others were ridge-like and stretched away in league-long terraces, with other terraces beyond, and all alike were clothed in the gray everlasting thorny vegetation." There is, also, a striking lack of animal life. "All day the silence seemed grateful, it was very perfect, very profound. There were no insects, and the only bird-sound — a feeble chirp of alarm emitted by a small skulking wren-like species — was not heard oftener than two or three times an hour. The only sounds as I rode were the muffled hoof-strokes of my horse, scratching of twigs against my boot or saddle flap, and the low panting of the dog. And it seemed to be a relief to escape even from these sounds when I dismounted and sat down: for in a few moments the dog would stretch his head out on his paws and go to sleep, and then there would be no sound, not even the rustle of a leaf. For unless the wind blows strong there is no fluttering motion and no whisper in the small stiff undeciduous leaves, and the bushes stand unmoving as if carved out of stone." Day after day he was drawn to these dreary wastes and the peculiar state of mind seemingly induced by them is thus described: "During those solitary days it was a rare thing for any thought to cross my mind: animal forms did not cross my vision or bird-voices assail my hearing more rarely. In that novel state of mind I was in, thought had become impossible. Elsewhere I had always been able to think most freely on horseback; and on the pampas, even in the most lonely places, my mind was always most active when I travelled at a swinging gallop. This was doubtless habit; but now, with a horse under me, I had become incapable of reflection; my mind had suddenly transformed itself from a thinking machine into a machine for some other unknown purpose. To think was like setting in motion a noisy engine in my brain and there was something there which bade me be still, and I was forced to obey. My state was one of suspense and watchfulness; yet I had no expectation of meeting with an adventure and felt as free from apprehension as I feel now when sitting in a room in London. The change in me was just as great and wonderful as if I had changed my identity for that of another man or animal; but at the time I was powerless to wonder at or speculate about it; the state seemed familiar rather than strange, and although accompanied by a strong feeling of elation, I did not know it — did not know that something had come between me and my intellect — until I lost it and returned to my former self — to thinking, and the old insipid existence."

The peculiar state of mind here described the author attributes to a reversion to a primitive and savage mental condition, a state of intense watchfulness and alertness, but without the exercise of any of the higher mental faculties. He believes that man still retains much of the savage in him and this is brought out in wild and desert places, in times of great danger and under many adverse circumstances. This, like many other questions, touched upon or discussed, is food for thought for the reader.

JOSEPH F. JAMES.

Washington, D. C.

The Coal-Tar Colors, with Especial Reference to Their Injurious Qualities and the Restriction of Their Use: A Sanitary and Medico-Legal Investigation. By THEODORE WEYL. Translated, with permission of the author, by Henry Leffmann, M.D., Ph.D. Philadelphia, P. Blakiston, Son, & Co.

THE coal-tar colors having replaced the vegetable products in all branches of dyeing, a study of their sanitary relations becomes of great interest, and the more particularly, too, because of their rapidly extending application in the coloration of foods and of articles of daily household use. The call for active legislation in these matters has become imperative, but the exact legal status of the new colors has not yet been clearly defined, nor has their physiological action been sufficiently demonstrated. The civilized governments have passed laws regulating the sale and use of certain coal-tar colors, but, in correspondence with the imperfect knowledge we have as yet attained in this branch of science, these legal statutes proved inadequate and failed in their purpose. To determine by direct experiment the physiological action of the colors in question, and thus to provide a basis for a new and better legislation, was the work undertaken by Dr. Weyl, and this little book upon the sanitary relations of the coal-tar colors, translated from the German by Dr. Leffmann, is the published account of these same experiments, together with much else of importance and interest. The book is somewhat technical, but this need deter no one from its perusal, for, as Dr. Leffmann remarks in his preface, "the essential matter is so distinctly set forth that the chemical portion may be passed by those who are unable to comprehend it." There is no portion that may not be read with profit by all, the technicalities are well masked behind good English, and, thanks to Dr. Leffmann, we have a book of live interest from beginning to end. Reviewing the book critically, we have but one fault to find, and that with the arrangement. It will suffice to name the parts in their order as follows: Translator's Preface, Preface, Contents, Introduction, General Part, to page 34, Appendix, pages 35-60, Special Part, pages 61-148, Appendix, Index. This seems to us an original system of book-making, but, after all, change the *names* of the parts, and we have everything in proper place.

Beginning the book with the General Part, we have a few pages on the preparation of the coal-tar colors, their classification, nomenclature, commercial forms, uses, etc. The so-called poisonous colors are then discussed, and the arsenical nature of many of the earlier manufactures is pointed out. Fuchsine, for exam-

ple, thanks to its contained arsenic, was long regarded as poisonous, until being produced in a state of purity, its entire harmlessness was demonstrated. There is a general review of the laws regulating the use of poisonous colors, and then, *verbatim*, the enactments of Germany under date of July 5, 1887. In 1888 there were appended to the said enactments regulations as to the examination of colors, fabrics, fruit jellies, liquids, etc., for arsenic and tin, and these Dr. Weyl has given in full. The methods are interesting and exact, though not original. The laws of other countries than Germany are given in some detail, and then we pass to the experimental part, the method to be followed being first described. As it was out of the question to test all, or even the greater portion, of the numberless coal-tar derivatives, Dr. Weyl selected such as were suspicious or had already been regarded as poisonous and endeavored to take those in most general use. Of the nitroso colors, we have dinitrosoresorcinol and naphthol green, B. The nitro colors include picric acid, saffron-substitute, Martins' yellow, naphthol yellow S, brilliant yellow, and aurantia, and of these only the sulphonated colors, naphthol yellow, and Martin's yellow were found to be harmless. The azo- colors are discussed at some length from both a technical and toxicological standpoint, but of the twenty-three colors examined only two, metanil yellow, and orange II., produced distinctly poisonous effects when administered by the stomach. Many, however, developed a slight albuminuria, and one at least was plainly poisonous when introduced into the subcutaneous cellular tissue.

It is highly gratifying to remark the comparative harmlessness of by far the greater number of the coal-tar colors, and even in those colors which are indicated as poisonous such large does are necessary in order to produce toxic effect as to render accidental poisoning from the same a practical impossibility.

Much honor is due Dr. Leffmann for his part in giving to the English-reading public this book, the first on the subject in our language,— but the hearty reception it has met with from chemist, medico-legal expert, and medical practitioner alike, bespeaks sufficiently its worth and opportune appearance.

CHARLES PLATT.

Alternating Currents. By FREDERICK BEDELL, Ph.D., and A. C. CREHORE, Ph.D., Instructors in Physics, Cornell University. New York, W. J. Johnson Co.

THE Johnson Co. is to be congratulated upon the appearance and make-up of this volume. The large, clear print, good paper, and well-drawn figures, make it one of the best books, from a mechanical standpoint, which has ever been published. On careful examination there does not appear to be a single misprint, or a single error in the mathematical formulæ, in marked contrast to the slipshod English and errata which disfigure almost every page of Fleming's book. No less are the authors to be congratulated on their work, for this book will probably be for years a standard text-book on the subject. Whatever one may find to criticise, it will not be the manner in which the subject is treated, nor mistakes in the treatment.

The subject is developed in a logical and simple manner. In Part I., which contains the analytical methods, we have, after an introduction on the elementary notions of the magnetic field, current flow, and harmonic motion, the general equation for circuits with resistance and self-induction; then the solution to this equation, and its application to the different cases possible. The constants of the equation are determined in each case, and curves plotted from actual values of the resistance and self-induction. Next in order come the general equations for circuits with capacity and resistance, and circuits with resistance, capacity, and self-induction. These are treated in the same manner. All possible cases are considered, the constants determined and curves drawn to illustrate the solutions.

Chapters xii. and xiii. treat of circuits with distributed capacity and self-induction, a subject of the utmost importance in these days of long-distance telephoning and telegraphy.

Part II. contains the graphical treatment. The analytical results obtained in Part I. are made use of as a foundation for the graphical methods. In addition to the cases considered in Part I. we have cases of circuits, in series and parallel, containing different voltages, resistances, self-inductions and capacities, and the results of variations of the latter in such circuits. At the end of the book is given a table of mechanical and electrical analogies, amplified from that previously given by other writers. The consistent notation used throughout the book gives an added pleasure to its perusal.

There are some things omitted which might have been treated of with advantage. For instance, though the graphical solution of problems concerning divided circuits is given, the analytical is not. If Lord Rayleigh's method were the only one known, there might be a reason for this, but those who are readers of *La Lumiere Electrique* and *L'Electrician*, will call to mind various neat and simple methods of treating the subject, and the latter is too important, practically, to be able to do without any thing which can add to our information.

We understand that the authors have underway a volume on alternating circuits containing iron. With Kennelly's and Steinmetz's laws, we may expect from the analytical treatment much that is new and important with regard to the best size and dimensions of transformers for given efficiency and output, etc.

This work has been adopted as a text-book by a number of American universities, Cornell, Purdue, University of California, and others.

R. A. F.

Comparative Philology of the Old and New Worlds with Reference to Archaic Speech. By R. P. GREG, F.S.A., F.G.S., etc. 1 Vol. LXXII. 355 p. Royal 8°. London, Kegan Paul, Trench, Trübner & Co., 1893.

IT it a painful duty for a reviewer to take up a work which is honest in intention and laborious in execution, but hopelessly deficient in method; and such is the one before us. To issue its considerably more than four hundred large pages must have cost the author a great deal of work and of money; yet for all scientific purposes the results he reaches, must be estimated as scarcely above zero.

The judgment may seem harsh, but let us see what he sets out to prove and what methods he adopts. He writes to support the hypothesis of an original unity of language, of an original common tongue, an archaic speech of great simplicity, composed of differentiated emotional and imitative utterances, fragments of which can be traced in all the languages of the world, bringing them, therefore, into a genetic relationship. To prove this, he devotes over 350 pages to "Tables of Accordances," lists of words which he believes to be from the same root in the most diverse tongues. The hypothesis is by no means a novel one, nor does he claim it as such, but perhaps it has not before been urged with such abundance of illustration.

Whatever one thinks of the hypothesis, all will agree that a competent knowledge of linguistics should be asked in its supporters, if they claim a hearing before the scientific public; and just here Mr. Greg is strangely deficient. His introduction begins with a survey of American languages, and as these figure largely in the tables, they will serve as a test of his work in general.

His authorities at once awake astonishment. Ignatius Donnelly's "Atlantis," the second-hand reports of Bancroft, Canon Cook, Hyde Clark, and Bradford, the tracts of Professor Campbell, and Vincente Lopez, and a few unimportant and defective vocabularies, such as these of Marcoy and Parry, are the books that figure most prominently in his "list of authorities" What he has learned from them is on a par with their value. He speaks (p. x.) of "the ancient Nahua and Aztec languages of Mexico," unaware that these words are merely different names for the same language. On the same page he refers to the "Californian" language, as if any such existed; and attributes to Schoolcraft (instead of Lieber) the term *holophrastic*, as applied to American idioms. Who "Dr. Daniel Whitney, the well-known American philologist," may be, will certainly puzzle readers, as he is surely not known on this side of the Atlantic.

When it comes to the tables of accordances, all American languages are conveniently divided into northern, central, and

southern. It would go hard with a student if in this broad field he could not find a word somewhat analogous in meaning to any other word in any other language; particularly were the student satisfied as easily as Mr. Greg. For instance, among his "accordances" there are plenty of instances of analogies like the following: Accadian, *shuku*, wheat, American, *mays*, maize; Accadian, *ka*, life, American, *ak*, water; Hebrew, *ben*, son, American, *hua*, son; Thibetan, *sna*, to breathe, American, *cenka*, noise; Indo-Chinese, *petan*, bird, American, *pa-hue*, to fly, etc. Thousands of his "accordances" are no closer than these.

But the unscientific spirit of the book is only too painfully apparent throughout. All such mere phonetic similarities, even where they are real and close, are of absolutely no value and prove nothing whatever concerning the relationship of linguistic stocks. This can only be demonstrated by studying the history and growth of a language, tracing its development and the influences to which it has been subjected, ascertaining the evolution of its grammatical forms and categories, separating the original elements from grafts and accretions, and confining comparisons to the former exclusively, and then only in the forms which existed at the earliest ascertainable epoch. Any such method as that adopted by Mr. Greg, in which these elements of linguistic growth are omitted, and even in which identity of alphabetic value is not attempted, is wholly valueless; and it is most unfortunate that all writers on linguistics have not been educated to recognize this fundamental principle of research.

An Atlas of Astronomy. By SIR ROBERT STAWELL BALL, LL.D., F.R.S. New York, D. Appleton & Co.

IN this work Sir Robert Ball has added a handy companion to his "Star Land." The atlas contains a series of seventy-two plates explanatory of the sun, moon, major planets, and fixed stars. The object of the atlas is to put into a convenient form, for the amateur astronomer, those data that will interest in a study of the evening sky. The author has in the introduction given the usual definitions of the coördinates of the position of a heavenly body as seen projected upon the celestial vault. A very neat explanation of the manner in which the orbit of a binary star is computed, is given, and as the process is so simple young astronomers will find in the construction of the orbits of the hundreds of binary stars very interesting instruction. The lunar maps, although upon a small scale, are very complete, giving as they do a representation of some part of the moon's surface throughout the whole lunation. A good selection of telescopic objects, such as interesting double stars, nebulæ, and rich star clusters is also given. The name of each object and its position in the sky are given as well as a short explanatory note describing the object. We note that some of the explanations given by the author are a little abstruse. On page 2, in describing the path of a planet, the words ellipse and orbit seemed to be woefully mixed up, so that it is difficult to follow the meaning of the author. For example, we have the statement that "the line *PA* through the two foci is the axis major of the ellipse. This is immediately followed by the statement that "it is bisected in *O* at the centre of the orbit." An orbit and an ellipse are not the same by any means, and should never be considered as such. A few lines following we have the statement that "the point *P*, nearest the sun, is the perihelion of the orbit. We certainly fail to see the truth of that statement. We should say that *P* was the perihelion point of the object moving in the orbit. The same criticism applies to the point of aphelion. Again, we must question the statement that "the time that the planet takes to go around its orbit is the periodic time." We were not aware that a planet went around its orbit. If it does, what is the name of the path in which the planet itself is moving? Upon the whole, the work has been neatly arranged, and the publishers have made it attractive both in style of printing and in neatness of binding. We would recommend the book to those who are seeking for some popular work that has in a handy form the interesting points in astronomy.

G. A. H.

CALENDAR OF SOCIETIES.

Philosophical Society, Washington.

Apr. 29.—Cleveland Abbe, Measurements of the Growth of Plants with the Auxanometer; Henry Farquhar, The Price of Silver; M. H. Doolittle, Is there an Objective Reality?

Appalachian Mountain Club, Boston.

Apr. 29.—Charles M. Skinner, Across British America.

May 3.—Lemuel C. Barnes, Mount Hermon in April; Charles C. Hall, The Shawangunk Mountains.

Society of Natural History, Boston.

May 3.—R. T. Jackson, Notes on the Development of Palms.

Royal Meteorological Society, London, England.

Apr. 19.—"The Direction of the Wind over the British Isles, 1876–80," by Mr. F. C. Bayard, F.R. Met. Soc. This is a reduction on a uniform plan of the observations made twice a day, mostly at 9 A.M. and 9 P.M., at seventy stations during the lustrum 1876–80, and the results are given in tables of monthly and yearly percentages. "Notes on Two Photographs of Lightning Taken at Sydney Observatory, Dec. 7, 1892," by Mr. H. C. Russell, F.R.S. These photographs were taken with a ¼-plate view-lens, mounted in a whole-plate camera, and, as a matter of course, there is some distortion at the edges. Both photographs show the gas-lights in the streets as white specks, the specks being circular in the centre and crescent-shaped in other parts of the plate, owing to distortion. The lightning-flashes are also distorted. Mr. Russell believes that this distortion may account for the so-called "ribbon" flashes which are seen in many photographs of lightning. He has also made some measurements of the length and distance of the flashes, and of the intensity of the light. "Notes on Lightning-Discharges in the Neighborhood of Bristol, 1892," by Dr. E. H. Cook. The author gives some particulars concerning two trees in Tyntesfield Park which were struck by lightning, one on June 1 and the other on July 18, and also some notes concerning a flagstaff on the summit of Brandon Hill, which was struck on Oct. 6. "Constructive Errors in Some Hygrometers," by Mr. W. W. Midgley, F.R.Met.Soc. The author, in making an investigation into the hygrometrical condition of a number of cotton mills in the Bolton district, found that the mounting of the thermometers and the position of the water receptacle did not by any means conform to the regulations of the Royal Meteorological Society, and were so arranged that they gave the humidity results much too high. The "Cotton Factories Act" of 1889 prescribes the maximum weight of vapor per cubic foot of air at certain temperatures; and the author points out that, if the instruments for determining the amount present in the mills have an error of 20 per cent against the interests of the manufacturer, it is necessary that the makers of the mill hygrometers should adopt the Royal Meteorological Society's pattern for the purpose.

Introduction à la Théorie des Explosifs. PAR M. E. SARRAU, Ingénieur en Chef des Poudres et Salpêtres, Membre de l'Institut. Paris, Gauthier-Villars et Fils, 1893. 115 p.

To the student of applied and theoretical mathematics this work of the eminent M. E. Sarrau will be most welcome. Unfortunately our language can boast of but little on the mathematical theory of explosives, and that little mainly in isolated chapters, imperfect and confusing in their briefness. Whether this be due to lack of interest or of study, we do not care to discuss, but certain it is that for a clear exposition of mathematical thought we must turn to writers of other lands than ours. From France we have received many of our best works, and it is with pleasure that we now announce this new work from the hand of M. E. Sarrau. A prefatory note, four lines in all, states the author's intention to bring forward such mechanical, thermo-chemical, and thermodynamical problems as are necessary to a comprehensive theory of explosives. Throughout, the discussion, which is both analytical and general, is so clearly and concisely accomplished as to be quite within the understanding of any student versed in differential and integral calculus. The first chapter treats analytically of the mechanical principles, including work, kinetic energy, and potential energy. In the second chapter are established the general laws of gases, Mariotte's, Gay-Lussac's, the law of specific volume, the hypotheses of Avogadro and of Ampere, the molecular and atomic weights, the molecular volumes, and the chemical formulæ. In this same chapter are studied the laws governing the specific heat of gases and the laws of gaseous mixtures. Chapter III. treats of the thermo-dynamics of perfect gases, and Chapter IV. of the general principles of thermo-dynamics, including thermal phenomena, equivalence, and the principle of Carnot-Clausius. Chapter V. is devoted to liquids, the law of compression, and the equations of Van der Waals and Clausius. The preceding theories and principles are applied in Chapter VI. to the various transformations, first without change in physical state and then with change from one state (of pressure, temperature, and volume) into another. The nature of heat is discussed in Chapter VII., and the heat theory of chemical reactions in Chapter VIII. Chapter IX., the last in the book, contains a study of dissociation, theoretical and practical. It will be noticed that the author has confined himself strictly to his outline as planned, and the work is, as the title indicates, merely an introduction to the further and advanced study of explosives, but it is such an introduction as comes from a master hand, and is suggestive of latent power and of the ability to pursue the demonstration to its completion.

C. P.

THERE will be given at the gallery of the Boston Art Club, under the auspices of the Appalachian Mountain Club, from the 6th to the 24th of May, a remarkable exhibition of mountain photographs by Vittorio Sella of Biella, Italy. In addition to the exhibit (327 subjects) to which the "diploma of honor and large gold medal" has just been awarded at the competitive exhibition in Turin, it is expected that nearly two hundred other subjects will be represented, making it the most extensive exhibition of Sella's work ever given. The collection will fully represent the mountains of Dauphiny, Switzerland, the Tyrol, Sicily, and the Caucasus.

—Lieutenant Peary of the United States Navy, during his coming expedition to northernmost Greenland, will record observations of the aurora, upon a plan that will enable comparisons to be made in detail with records from other localities. The plan is already in operation, upon an international basis, and the results are proving to be important. Numerous observers widely distributed are desirable, and, inasmuch as even those who have no special technical knowledge may make entries that will be of value, any who feel so disposed may coöperate. Further information and supplies of blanks may be obtained from M. A. Veeder, Lyons, New York, U.S.A., who will be glad to receive, also, any records of observations of the aurora whatever, for purposes of comparison.

Exchanges.

[Free of charge to all, if of satisfactory character. Address N. D. C. Hodges, 874 Broadway, New York.]

Texas Plants. I will collect sets of plants represented in this region of Texas, either for sale or for exchange for literature, for anyone who will send me an order in time to fill it. Plants to be ready complete in November. C. F. Maxwell, Box 174, Dublin, Texas.

For sale or exchange—A Telescope (36 diameters, copper barrel)—for $90 cash or scientific books of that value. A. N. Somers, La Porte, Ind.

For sale—A complete set of the Reports of the Second Geological Survey of Pa., 1874-1895, including the Grand Atlas. Publisher's price over $115. Will sell for $50. Address F. D. Chester, Newark, Del.

The undersigned has skins of Pennsylvania and New Jersey birds, as well as other natural history specimens: which he wishes to exchange for marine, fresh water, and earthworms of the South and West. Correspondence with collectors desired. J. Percy Moore, School of Biology, University of Pennsylvania, Philadelphia.

For sale or exchange.—I have a Caligraph typewriter (No. 2) in perfect order and nearly new. It is in a heavy leather, plush-lined office case, the whole costing me about $100. I desire to obtain for it, either by sale or exchange, a new, No. 5 "Kodak" camera, with six double feather-weight plate-holders and the latest pattern of their tripod. The lens and pneumatic time-shutter must also be the same as those now sold with the last No. 5 Kodak. The price of what I desire in exchange is $75. Address, for particulars, P. O. Box 314, Takoma, District of Columbia.

For sale.—An Abbe binocular eye-piece for the microscope. Alfred C. Stokes, 527 Monmouth St., Trenton, N. J.

For sale or exchange.—One good long range Remington B. L. rifle, 44 calibre, also land and fresh water, and marine shells. Want shells, Safety, camera or printing press. A. H. Boies, Hudson, Mich.

Fine collection of microscopic slides for sale, or would exchange for first-class pneumatic bicycle. J. E. Whitney, Box 549, Rochester, N. Y.

For sale—A Zentmayer new model U. S. Army Hospital monocular stand. Price $110, will sell for $75. Address H. C. Wells, No. 151 Broadway, New York.

Wants

WANTED, as principal of a flourishing technical school, a gentleman of education and experience who will be capable of supervising both mechanical and common school instruction. Special familiarity with some technical branch desirable. Address, giving age, qualifications, etc., J. B. Bloomingdale, Fifty-ninth street and Third avenue, N. Y.

WANTED.—A young man as assistant in our microscopical department. Queen & Co., Philadelphia.

THE undersigned desires specimens of North American Gallinae in the flesh for the study of their pterylosis. These species are especially desired: *Colinus ridgwayi, cyrtonyx montezumae, deudragapus franklini, lagopus welchi, tympanuchus cupido* and *pediocectes phasianellus*. Any persons having alcoholic specimens which they are willing to loan or who can obtain specimens of any of the above are requested to communicate with Hubert Lyman Clark, [illegible] Fifth Avenue, Pittsburgh, Pa.

A COMPETENT TEACHER of botany in college or university is open to engagement. Address L., Box 36, Rochester, Mich.

CAN any one inform me as to the age to which cats have lived? I have one twenty years old. Edward D. Webb, 189 W. Eighty-first St., New York.

WANTED — Second-hand. Foster's Physiology, Balfour's Comparative Embryology, Claus & Sedgwick's Zoology, Flower's Osteology of Mammalia, Vine's Physiology of Plants. Please state editions and prices asked and address Richard Lees Brampton, Ontario, Canada.

A GRADUATE ENGINEER will give instruction evenings in geometry, trigonometry and surveying, mechanics, physics, mechanical drawing and general engineering construction. Five years' experience in field and editorial work on engineering journal. References furnished. C. S. H., 109 Tribune Building, New York.

WANTED.—By well-qualified and experienced science master and associate of the Royal School of Mines, London, aged 26 (at present in England), a mastership in technical college or university for any of the following subjects: Engineering sciences, geology and mineralogy, physics, chemistry and metallurgy, etc., etc. Can provide excellent references and credentials. Apply, J. G., 17 Sussex St., Rochdale, England.